
DANGER

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The Paris Sewer Renaissance: Data, Health and Participatory Science

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Abstract
Aging urban wastewater infrastructure, often overlooked, can become a powerful lever for environmental and public health policy. Through the lens of the Parisian sewer system, this article highlights the growing pressures on sanitation networks – from combined sewer overflows to emerging chemical contaminants – and the limits of current treatment technologies. Yet, it also illustrates how wastewater can serve as a valuable resource. Initiatives like OBÉPINE have demonstrated the feasibility of wastewater-based epidemiology at scale, while participatory initiatives such as those performed in EGOUT show that citizen engagement and scientific monitoring can go hand in hand. Together, these efforts redefine wastewater as more than waste: It is a mirror of collective behavior, a platform for community science and a tool for decision-making. As cities face urgent climate and health challenges, this work calls for policies that reconnect people with infrastructure and invest in data-driven, inclusive approaches to urban sustainability.

KEYWORDS

water quality
wastewater
chemical contamination
microbial contamination
participatory sciences

WATER ICONS





Policy Recommendations

- Wastewater-based epidemiology (WBE) has transformed sewers into real-time monitoring tools, with initiatives like OBÉPINE in France demonstrating their value for national health surveillance and broader environmental policy.
- Aging combined sewer systems like Paris's face mounting pressures from climate change, urban densification, and emerging contaminants, making combined sewer overflows a persistent environmental and regulatory challenge.
- Participatory projects such as EGOUT show how wastewater science can reconnect citizens with invisible infrastructure, using co-designed interventions to link daily habits, health promotion, and community engagement.

< Fig. 1 Management operation in the sewer network (Source: Jérémy Jacob, 2025).

Introduction

Urban sewer systems form the foundation of modern sanitation, yet their age and invisibility have led to growing disconnections between infrastructure, public health goals and citizen engagement. In Western Europe, most networks date to the nineteenth century and have evolved incrementally rather than through comprehensive renewal. These combined sewer systems (meaning systems in which both stormwater and wastewater flow through the same pipes), like the system in Paris, now face mounting pressure from climate change, increased urban density and a growing array of chemical and biological contaminants. Combined sewer overflows (CSOs) during rainfall events discharge untreated wastewater into the environment and pose regulatory and ecological challenges that demand both technological upgrades and adaptive governance.

The legacy of outdated infrastructure also limits society's ability to respond to emerging threats, whether chemical (e.g., pharmaceuticals, PFAS, endocrine disruptors) or biological (e.g., viruses). However, recent developments in wastewater-based epidemiology (WBE), particularly during the COVID-19 pandemic, have revealed new ways to leverage this invisible infrastructure for real-time monitoring of population health and environmental pressure. Initiatives like the French OBÉPINE (Observatoire Épidémiologique dans les Eaux Usées) network have shown that wastewater data can inform national health policy, while opening new possibilities for local decision-making.

At the same time, reengaging citizens with their sewer systems, traditionally managed out of sight and out of mind, offers pathways toward participatory urban sustainability. Projects such as EGOUT (Extended Geochemical Observation of Urban Trajectories) demonstrate that wastewater can serve as a medium for public engagement, data co-production, and health promotion. This article introduces the converging challenges and opportunities of aging urban sewers, arguing for a renewed policy agenda that links infrastructure, science, and civic action.

Aging Sewers, Emerging Threats: The Hidden Challenge of Urban Wastewater

Western European sanitation networks mainly date back to the late nineteenth century and share common characteristics, one of the most significant being that they are often combined sewer systems. This has been the case for the Parisian sewer network since 1833. Such a network was a matter of national pride by the end of the nineteenth century, particularly with the discovery of the pathogenic role of waterborne diseases, such as cholera, and the system drew visitors of that era who were interested to observe how the system worked. This national pride has gradually declined, mostly as the system has become invisible to the public and city residents have lost knowledge of the system beyond waste transport (Barles 2007). In the run-up to the 2024 Olympic Games and during the COVID-19 pandemic, sewage returned to the news, but for different reasons. In relation to the Olympics, there was the plan to improve the network's capacity to limit direct discharges into aquatic environments, particularly during intense rainfall events, by developing storage capacity. In relation to the pandemic, attention was drawn to a plan to use wastewater to estimate the amount of SARS-CoV-2 circulating in the population.

However, this kind of sewer system is highly vulnerable to rapid overloading during intense

rainfall events on impervious surfaces, leading to CSOs of raw wastewater mixed with runoff from urban surfaces. Although episodic rather than continual, these CSOs are major sources of contamination for water bodies (Petrie 2021), particularly in terms of emerging contaminants, fecal bacteria and plastics. To mitigate them, storage capacities have been implemented to store temporary raw water during rain events (for example, in Paris in preparation for the 2024 Olympic Games). However, their total capacity remains limited and is designed to handle only frequent but moderate rainfall events (Lucas et al. 2020). It is also important to note that when considering chemical pressure on the receiving environment, it is primarily everyday practices, whose residues are not fully treated in wastewater treatment plants (WWTPs) that contribute to this pressure.

The intense urban concentration and densification of the past century, relying on sanitation networks that have been adapted rather than completely renewed, have tested the ability of receiving environments to absorb pollution. These environments are experiencing increasing chemical pressure, sometimes exceeding critical thresholds (e.g., massive deoxygenation, eutrophication), which significantly impacts ecosystems and biodiversity. While the widespread improvement in wastewater collection and treatment has recently reduced issues related to traditional water quality parameters such as carbon (C), nitrogen (N) and phosphorus (P), advancements in analytical capabilities and the expansion of the range of molecules being monitored have highlighted a major issue (Soares 2020). Current wastewater treatment processes are not well-suited to removing certain pollutants that involve particularly persistent and very mobile molecules (e.g., trifluoroacetic acid).

Wastewater Analysis as a New Frontier in Environmental and Public Health Monitoring

Awareness of low-dose environmental contamination by micropollutants has stimulated growing interest in monitoring raw wastewater prior to treatment, particularly to assess the efficiency of wastewater treatment processes. Raw wastewater is highly representative of population usage as it is closer to the source of human excretion and contains a wide range of detectable molecules. This proximity has laid the foundation for WBE, a discipline that quantifies daily human activities and uses through chemical analyses of wastewater. Initially focused on the detection of illicit drugs, WBE has expanded to include a broad spectrum of compounds, such as pharmaceuticals and pesticides, enabling insights into population-level exposure and consumption patterns. To produce meaningful interpretations, WBE requires accurate quantification of target compounds and correction factors such as human excretion rates and in-sewer degradation dynamics. Similar to approaches used for river monitoring, composite sampling is typically employed in wastewater studies to account for temporal variability. However, raw wastewater presents considerable analytical challenges due to its complex composition and matrix, requiring several steps to isolate micropollutants and pathogens from the organic matrix.

In France, and particularly in Paris, several initiatives aim to use wastewater for public health monitoring. The OBÉPINE network has played a pioneering role in applying WBE at a national scale, and particularly in the Parisian conurbation. Established during the COVID-19 pandemic, OBÉPINE demonstrated the viability of wastewater as a real-time health surveillance tool by tracking SARS-CoV-2 levels across hundreds of wastewater treat-

ment plants (Wurtzer et al. 2022). The network's success brought WBE into the public spotlight and underscored the value of decentralized, high-frequency sampling for public health decision-making. Beyond its application to viruses, OBÉPINE set a precedent for infrastructure, coordination and data interpretation that could be extended to other chemical and biological markers. The experience gained during the pandemic has laid the groundwork for integrating wastewater monitoring into broader environmental and health policies, particularly in urban areas where decision-makers face growing pressure to assess chemical exposure and improve quality-of-life indicators such as bathing water safety. Other Parisian initiatives on contaminant monitoring in wastewater for practice estimation are also promoted by the SIAAP (sewer manager) under its micropollutant observatory initiative, and the EGOUT project.

One ongoing challenge in expanding WBE lies in the need to monitor not just persistent xenobiotics but also labile endogenous compounds, such as human metabolic markers. These molecules degrade quickly in wastewater, yet they offer valuable insights into health, diet and stress. The ability to detect these compounds reliably would enhance WBE's relevance for preventative health monitoring, which will be an objective of a new project centered on the Parisian context, WHAOU (Well-Being and Health Observatory within Urban Trajectories). In the post-COVID context, the legacy of these wastewater-monitoring experiences make this socially and politically useful but buried heritage visible. It highlights wastewater's untapped potential as both a scientific resource and a tool for proactive public policy on health and sustainability.

Reconnecting Residents with Sewers through Participatory Action

While monitoring public health in large populations is notoriously difficult, particularly when



^ Fig. 2 Researchers and a Parisian volunteer presenting the experiment and distributing recipes at markets in the 20th arrondissement (Source: Jérémy Jacob, 2025).

timely, granular data is needed, the potential contribution of the sewer network in this endeavor is mostly invisible and unknown to the residents. Within the EGOUT project, an initiative was undertaken to reconnect residents to their sewers (fig. 2). The aim was to explore whether WBE could detect dietary changes during a community-driven dietary intervention and, in doing so, reconnect residents with their wastewater system through a shared scientific initiative. The initiative took place in Paris's 20th arrondissement and potentially involved over 100,000 residents, with a focus on the Pyrénées Elementary School. In collaboration with teachers, local officials and the Paris Volunteers network, a participatory campaign encouraged increased fruit and vegetable intake during a dedicated week. Researchers monitored wastewater before, during and after the intervention, analyzing specific biomarkers related to plant-based diets and vitamins.

To ensure engagement, the action was co-designed with 104 residents and publicized via local markets, media outlets and a school program involving 150 children. Communication avoided moralizing tones, instead framing the project as a "scientific adventure" that celebrated transparency and community input. Children created sewer models and visited the Paris Sewer Museum, helping translate the science to their families and neighbors. Recipes, educational videos and public events further supported community involvement. Wastewater samples were analyzed for eight chemical markers, including fiber tracers and vitamin B metabolites. Of the six relevant dietary tracers, four showed statistically significant increases during the intervention week, suggesting a measurable shift in food consumption (Thiebault et al. 2025). Control compounds like saccharin and paracetamol remained stable, reinforcing the dietary origin of observed changes. While individual intake could not be quantified due to population-wide sampling and varying excretion rates, the experiment showed that wastewater could reflect collective lifestyle shifts. Beyond data, it redefined wastewater as a community asset, both a mirror of urban behavior and a platform for civic engagement. Importantly, the project avoided privacy concerns by emphasizing aggregated, anonymous data, and involved the public throughout, from planning to results dissemination. Branded with the playful slogan ''Donner mon caca à la science'' (give your poo to science) the project reframed wastewater as a tool for health promotion and local empowerment. It opened up conversations about sustainable diets, food accessibility and the future of community-based monitoring. By linking daily habits with invisible infrastructure, the initiative reconnected residents with the urban sewer system and demonstrated the potential of wastewater science to support participatory urban sustainability.

Conclusion

Urban wastewater systems are at a crossroads. Originally designed for a different era, they now face mounting environmental, public health and societal pressures. Yet within these challenges lies an opportunity to reframe sewers not merely as conduits for waste, but as tools for monitoring, prevention and civic dialogue, thereby promoting a new way of thinking about these underground infrastructures.

The growing field of wastewater-based epidemiology, as demonstrated by initiatives like OBÉPINE, has proven the potential of sewage as a public health resource. Meanwhile, participatory projects such as EGOUT show that communities can be meaningfully engaged in

how wastewater is interpreted and used upon. Together, these approaches point toward a new policy horizon – one that integrates infrastructure renewal, scientific innovation and democratic participation.

Moving forward, aligning environmental and health objectives with sewer system upgrades will be essential. This means funding data-driven monitoring programs, enabling local experimentation and promoting public awareness. If embraced strategically, wastewater can become a powerful vector for urban resilience, social engagement and sustainable health policies – turning an aging network into a platform for renewal.

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